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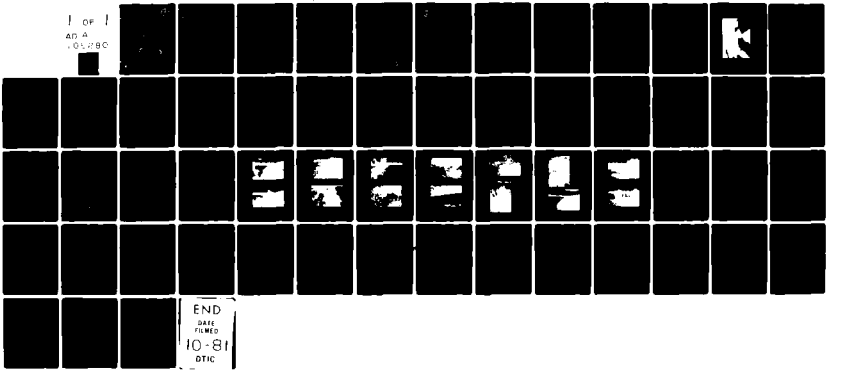

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OKAYDY RESERVOIR DAM

HOWARD COUNTY, MISSOURI

MO. 10001

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JUNE, 1979

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National Dam Safety Program. Okaydy Reservoir Dam (MO 10001) Missouri - Kansas City Basin, Howard County Missouri. Phase I Inspection report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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OKAYDY RESERVOIR DAM
HOWARD COUNTY, MISSOURI
MO. 10001

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JUNE, 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Okaydy Reservoir Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Okaydy Reservoir Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass the Probable Maximum Flood.
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division — 20 DEC 1979 (Date)

APPROVED BY: SIGNED
Colonel, CE, District Engineer — 20 DEC 1979 (Date)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Okaydy Reservoir Dam
State Located	Missouri
County Located	Howard County
Stream	Cottonwood Creek
Date of Inspection	June 1, 1979

Okaydy Reservoir Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately one-half mile (and at this point enters Missouri River floodplain) downstream of the dam. Within the one-half mile damage zone is the town of Franklin with approximately 70 dwellings.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Due to the close proximity of the town of Franklin and the number of dwellings the Probable Maximum Flood is the appropriate spillway design flood. The spillway will pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillway will pass 25% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

No design data were available for this dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future.

Other deficiencies noted during the inspection are erosion of the upstream face at two locations, trees and shrubs growing along the waterline, seepage along the downstream toe from the left end to the right abutment trough, inlet sill of spillway blocked by beaver dam, small trees and brush growing on reservoir side of inlet sill, and downstream channel from spillway is overgrown with trees and brush.

Maintenance is, in general, good. Several items of preventative maintenance are more specifically covered in the body of the report.

Rey S. Decker
E-3703

Gordon Jamison

Michael McMeekin
E-4776

H. P. Hoskins
Harold P. Hoskins
Chairman of Board
Hoskins-Western-Sonderegger, Inc.
E-8696

PHOTO NO. 1 - OVERVIEW. DAM TO LEFT OF CENTER.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
OKAYDY RESERVOIR DAM - MO 10001
HOWARD COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Okaydy Reservoir Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth fill approximately 580 feet long and 23 feet ± in height. It is located in the deep loess hills of the Central Mississippi Valley physiographic area. It is one of two dams on the University of Missouri Franklin Horticultural Farm.

(2) The spillway consists of a channel excavated through the left abutment. It is lined with concrete rubble masonry with three concrete transverse sills. It has a bottom width of about 50 feet.

(3) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the south central portion of Howard County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the NW¼ of Section 29, T49N, R16W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends into the town of Franklin, approximately 0.3 mile downstream from the dam. Within the damage zone are about 70 dwellings which could be affected.

e. Ownership. The dam is owned by the University of Missouri, Room I-43, Agricultural Building, Columbia, Missouri 65211. Attention: Dr. Donald Hegwood.

f. Purpose of Dam. The dam impounds water originally used by the MKT Railroad. It now provides some flood protection for Franklin and supplemental irrigation water for the University of Missouri Franklin Horticultural Farm.

g. Design and Construction History. The dam was built by the MKT Railroad in 1904. The height of the dam was increased about 5 feet and the downstream slope flattened in 1954. Material for the additional construction was CL loess borrowed from the adjacent hills. The spillway was modified and improved in 1927. It was reported by Dr. Audrie Hibbard of the University of Missouri that the lake is silted in to about one-half the original capacity.

h. Normal Operating Procedure. There are no operating facilities for this dam.

1.3 PERTINENT DATA

a. Drainage Area. 2.19 square miles (1,403 acres)

b. Discharge at Damsite.

(1) All discharges at the damsite are through the concrete rubble masonry spillway channel.

(2) Estimated maximum flood - unknown.

(3) The spillway capacity varies from 0 cfs at its crest elevation to 1,600 cfs at elevation 620.9 (minimum top of dam).

c. Elevations. (Feet above M.S.L.).

(1) Top of dam - 620.9 (minimum)
(2) Spillway crest - 615.0
(3) Streambed at centerline - 598 ±
(4) Maximum tailwater - unknown.

d. Reservoir. Length (feet) of maximum pool - 6,500 ±

e. Storage (Acre-feet).

(1) Top of dam - 370 ±
(2) Principal spillway crest - 53 ±

f. Reservoir Surface (Acres).

(1) Top of dam - 65 ±
(2) Principal spillway crest - 32 ±

g. Dam.

(1) Type - earth fill
(2) Length - 580 feet ±
(3) Height - 23 feet ±
(4) Top width - 12 feet ±
(5) Side slopes.
(a) Downstream - upper 5 feet = 1.3H on 1V; 2.8H on 1V below this.
(b) Upstream - 2.2H on 1V from crest to elevation 618 ft. ± then near vertical to water line
(6) Zoning - unknown
(7) Impervious core - unknown
(8) Cutoff - unknown
(9) Grout curtain - unknown
(10) Wave protection - some old concrete slabs and rubble.
(11) Internal drainage - unknown

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal
(a) Type - excavated earth channel lined with concrete rubble masonry

(b) Crest elevation - concrete sill = 615 feet
Outlet - end of rubble masonry channel = 605 feet ± where it drops vertically to streambed
(c) Length - 52 feet ±, upper one-half on 13.7% slope, lower one-half on slope = 24.4%
(d) Upstream Channel - excavated earth
(e) Downstream Channel - natural creek bed

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

a. No design data were available for this dam.

2.2 CONSTRUCTION

a. No construction data were available. It was reported by Dr. Audrie Hibbard of the University of Missouri that the dam was built in 1904 by the MKT Railroad. The University of Missouri raised the dam and modified the downstream slope in 1954. The spillway was rebuilt in 1927.

2.3 OPERATION

a. No data were available on spillway operation. It was reported by Dr. Hibbard that spillway flows approached the maximum capacity in 1955 after a 5-inch rain.

2.4 EVALUATION

a. Availability. No data were available.

b. Adequacy. The field surveys and visual observations presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Okaydy Dam was made on June 1, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: R.S. Decker, Geotechnical; Gordon Jamison, Hydrology; and Mike McMeekin, Civil Engineer. Mr. Herb Biesemeyer, Farm Manager for the University of Missouri, accompanied the inspection team. Dr. Audrie Hibbard of the University of Missouri was interviewed in Columbia prior to the inspection.

b. Dam.

(1) Geology and Soils (abutment and embankment). This dam is located in the Central Mississippi Valley wooded slope soil association area. Soils on the uplands and slopes (abutments) consist of deep CL loess materials. Soils in the valley (foundation) consist of CL alluvium overlying glacial till (probably Kansan) or limestone/shale bedrock. No till or bedrock outcrops were observed at the site.

(2) Upstream Slope. The upstream face slopes on 2.2 to 2.5H on 1V from the crest elevation down about 3 feet (elev. 618 feet $\pm$) where it breaks to near vertical to the water surface at elevation 615.2 feet. Some riprap consisting of old concrete slabs and rubble was observed at or just above the water line. The slope above the riprap is fairly well vegetated with grass. A few small trees and shrubs are growing along the water line. Some erosion is noticeable above the riprap and two areas near Stations 2 + 10 and 1 + 20, show significant erosional damage with material removed almost to the crestline (see Photos 5 and 6).

(3) Crest - The crest is well vegetated with adapted grasses and was recently mowed. One large tree is growing on the downstream crest line near station 2 + 00. This tree was evidently left in place when the dam was enlarged in 1954. The profile of the crest is fairly uniform with one slight depressional area (0.3 to 0.5 ft. low) around Station 2 + 00. No cracks, rodent holes or lateral deformations were noted.

(4) Downstream Slope. The downstream slope is very well vegetated with adapted grasses. The upper 5 or 6 feet of the slope is much steeper (1.3H to 1V) than the remainder of the slope (2.8H to 1V). This probably reflects the construction that was done in 1954 when the height of the dam was increased. No other abnormal deformations, cracks, slumps or rodent holes were observed on the slope. Seepage outcrops along and out from the toe of the dam from the left end to the right abutment trough (downstream from about Stations 0 + 00 to 4 + 00). All seepage is clear and ponded (not flowing) along the toe. No boils were observed along the toe nor was there any evidence of the phreatic surface outcropping on the slope. Total seepage effluent was estimated at less than 0.5 gal/min if it had been collected and channeled. It was reported by Dr. Hibbard that the amount of seepage is reducing each year (probably the result of sedimentation in the reservoir).

(5) Miscellaneous. Borings on the dam indicate CL-CH materials to a depth of 2 feet. However, the erosion noted on the upstream face would indicate that at least some sections of the dam are not too resistant to erosion. With the excellent vegetative cover and the apparent CL-CH soils in the downstream section it would appear that the dam could withstand minor overtopping (less than 1 foot) without completely breaching the dam.

c. Appurtenant Structures.

(1) The spillway is lined with rubble masonry and has 3 transverse concrete stabilizing sills, one at the inlet crest, one downstream about midway and one at the end of the masonry lining. The lining and the sills look good with no significant deterioration. A low beaver dam extends across the inlet sill structure so that the reservoir level was slightly higher than the spillway crest elevation. Several small trees and shrubs are growing across the inlet to the spillway.

(2) Drawdown Facilities. It was reported by Dr. Hibbard that an 8 inch steel pipe line extends under the embankment to the railroad shops in Franklin, but it is now inoperable. Location of this pipe could not be determined. No other drawdown facilities exist.

d. Reservoir Area. Some erosion is evident around the shoreline of the reservoir, particularly around the left (north) side. However, no slides or slumps were observed.

e. Downstream Channel. The channel downstream from the spillway outlet is badly overgrown with trees and shrubs.

3.2 EVALUATION

a. This dam appears to be in good shape with the exception of minor deficiencies in controlling vegetation and erosion on the upstream slope. The slope and the apparent materials in the downstream section should provide adequate safety against shear failure for a dam of this height. Seepage along the toe does not appear to affect the safety of the structure but is considered a deficiency that should be investigated.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

a. There are no controlled outlet works for this dam. The pool level is controlled by rainfall, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

a. In general, maintenance of the dam and spillway appears to be good. Tree growth and erosion on the upstream face should be controlled, but it is doubtful that the one large tree on the crest will cause any significant damage to the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

a. No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

a. Upon checking with the owner we are unaware of any warning system in effect for this dam.

4.5 EVALUATION

a. There does not appear to be any serious potential of failure of this structure.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were available for Okaydy Reservoir Dam.

b. Experience. There are no available records of reservoir operation or frequency of spillway operation.

c. Visual Observations. The spillway consists of a 50-foot wide channel surfaced with concrete rubble masonry. There are 3 transverse concrete sills across the spillway channel. The upstream control sill is clogged by a beaver dam and several trees and shrubs growing along the crest. As a result, the reservoir water surface elevation is approximately 0.2' above the spillway crest. From the third transverse sill (end sill) downstream, the spillway channel is almost completely choked with trees and shrubs.

d. Overtopping Potential. According to the guidelines of the Department of the Army, Office of the Chief of Engineers, Okaydy Reservoir Dam is classified as having a high hazard rating and a small size. One half of the Probable Maximum Flood (PMF) to the PMF, therefore, is the recommended design flood for evaluation of the adequacy of the dam and its spillway.

The existing spillway will not pass 1/2 of the PMF or the PMF without overtopping of the dam. The spillway will pass the 100-year flood and approximately 25% of the PMF without overtopping. The dam could probably stand minor overtopping (less than 1 foot) without completely breaching the dam.

The results of the routings are tabulated below:

Flood	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	Freeboard Top of Dam Min. Elev. 620.9	Time Dam Overtopping Hr.
100 yr.	2,480	1,220	620.0	0.9'	0
0.50 PMF	5,260	4,970	622.7	-1.8'	$4\pm$
PMF	10,530	10,240	623.9	-3.0'	$7\pm$
0.25 PMF	2,600	1,600*	620.9	0.0	0

*Maximum spillway discharge

The drainage area of the Okaydy Reservoir Dam watershed was determined from the U.S.G.S. Franklin, Mo. and New Franklin, Mo. 7 1/2-minute topographic quadrangle maps. Reservoir surface area and elevation-storage data were determined from the Franklin quadrangle map. Computations for spillway and dam overtopping discharge ratings were based on surveys made during the field inspection. Hydraulic and hydrologic computations are described in Appendix D.

The estimated downstream damage zone is described in Paragraph 1.2d of this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. This dam appears to be structurally stable. The downstream slope, although steeper than normal in the upper section, should be stable against shear failures. Seepage along the toe does not appear to be critical but its effect on stability should be investigated and evaluated.

Analyses presented in Section 5 indicate that the dam will be overtopped by the Probable Maximum Flood by about 3.0 feet for 7 hours. The effects of such overtopping are not known.

b. Design and Construction Data. No design or construction data were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operating Records. There are no controlled operating facilities for this dam.

d. Post Construction Changes. It was reported by Dr. Audrie Hibbard that the dam was raised 5 or 6 feet and the downstream slope was flattened in 1954. The spillway was rebuilt in 1927.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. There does not appear to be a serious potential of failure of this structure. Floods exceeding 25% of the maximum design flood (PMF) will overtop the dam. Seepage along the toe of the dam is considered a deficiency. It is not known whether or not some of the seepage could be caused by leaks in the old water supply line which traverses the base of the dam. Additional studies would be required to determine the effects of such overtopping on the structural and erosional stability of the dam and the source of seepage and its effects on the structural stability of the dam.

b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The items recommended in paragraph 7.2.a relative to overtopping should be pursued on a high priority basis.

d. Necessity for Phase II. Phase II investigation is not considered necessary.

e. Seismic Stability. The dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

7.2 REMEDIAL MEASURES

a. Alternatives. (1) Additional information should be obtained on the topographic characteristics of the reservoir area to determine the increase in the height of dam or the size of the spillway that is necessary to pass the Probable Maximum Flood without overtopping the dam, (2) The source of the seepage along the downstream toe should be determined with particular reference to possible leakage from the old water supply line, (3) The services of an engineer experienced in the design of dams should be obtained to evaluate the present reservoir storage capacity, to provide seepage and stability analyses of the present dam, and to design protective measures, if required.

b. O & M Procedures.

(1) Trees and shrubs should be removed from the upstream face of the dam and measures taken to prevent their recurrence.

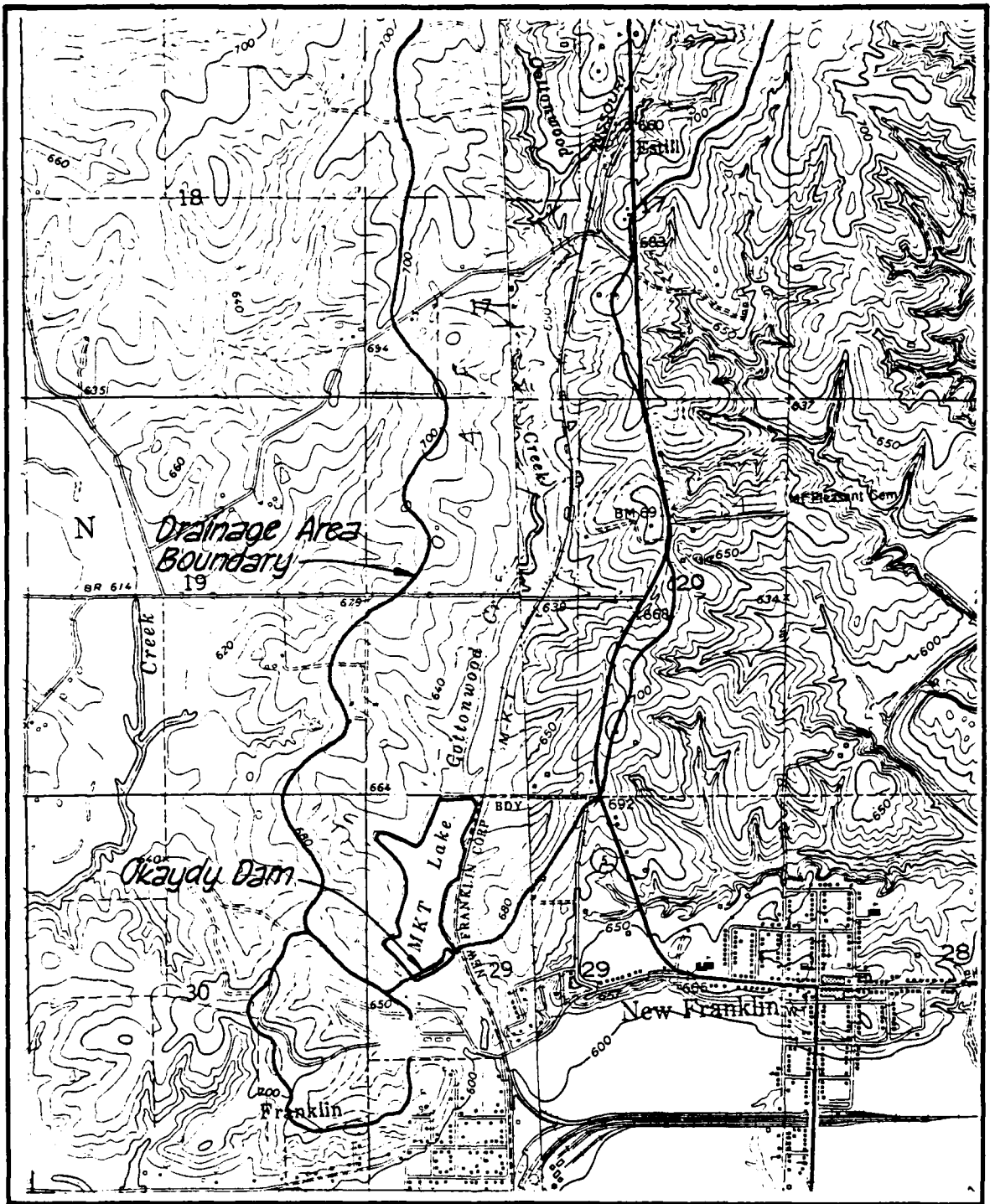
(2) The beaver dam, trees, and shrubs should be removed from the inlet of the spillway.

(3) Obstructions (trees, etc.) should be removed from the outlet channel of the spillway to the extent that the spillway will operate effectively under the design flood.

(4) Erosion on the upstream face should be corrected and measures taken to stabilize the slope with riprap or other means.

(5) A program of regular inspection and maintenance should be initiated to control vegetative growth and erosion on the embankment slopes and to eliminate or control the beaver activity.

APPENDIX A
MAPS



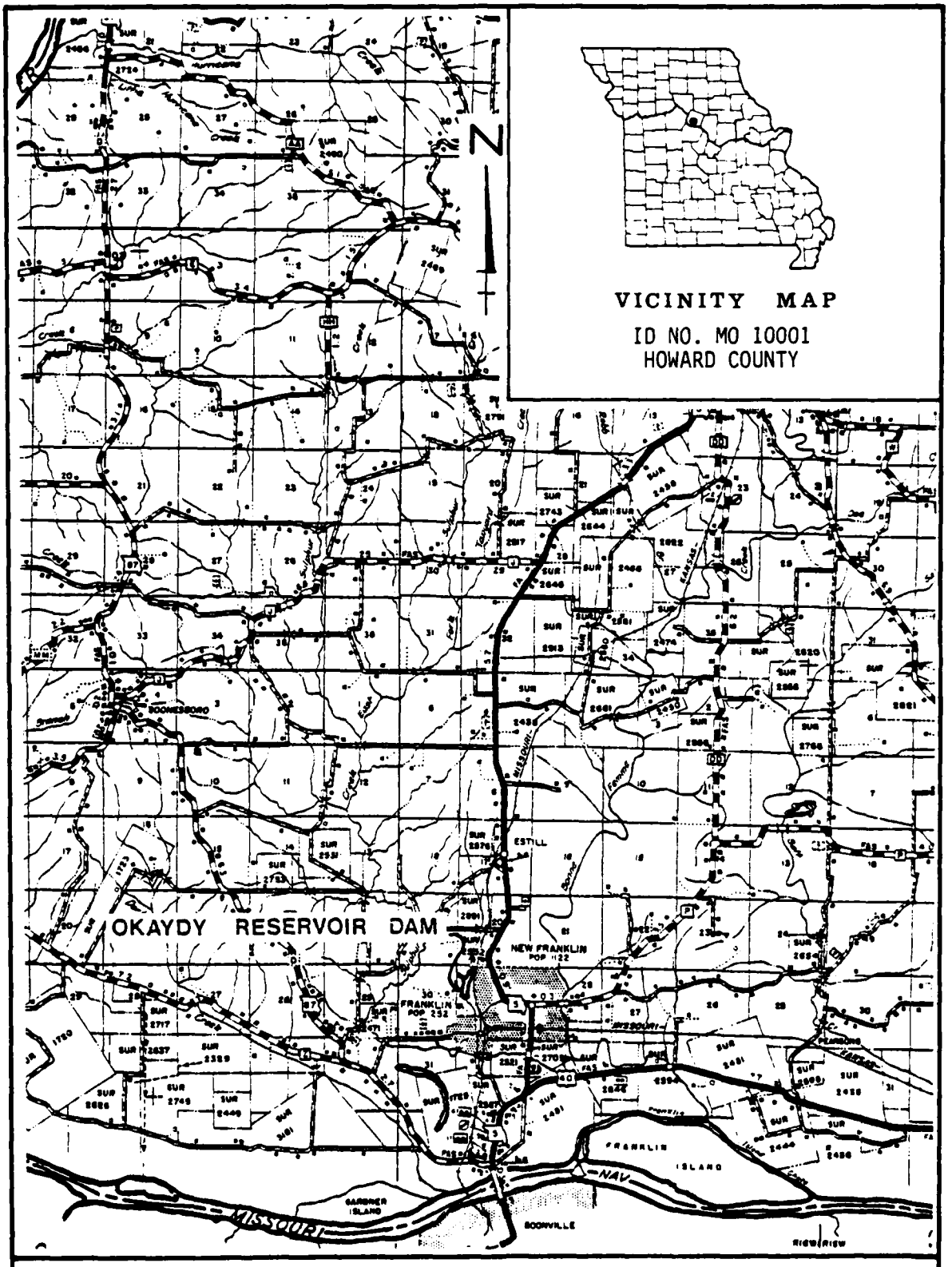
VICINITY TOPOGRAPHY

OKAYDY RESERVOIR DAM

HOWARD COUNTY, MISSOURI

MO. 10001

PLATE A-1


N
VICINITY MAP
ID NO. MO 10001
HOWARD COUNTY
OKAYDY RESERVOIR DAM
BOONESBORO
ESTILL
NEW FRANKLIN
POP 1122
FRANKLIN
POP 232
FRANKLIN ISLAND
NAV
MISSOURI
GARDNER ISLAND
BOONVILLE
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2

APPENDIX B
PHOTOGRAPHS

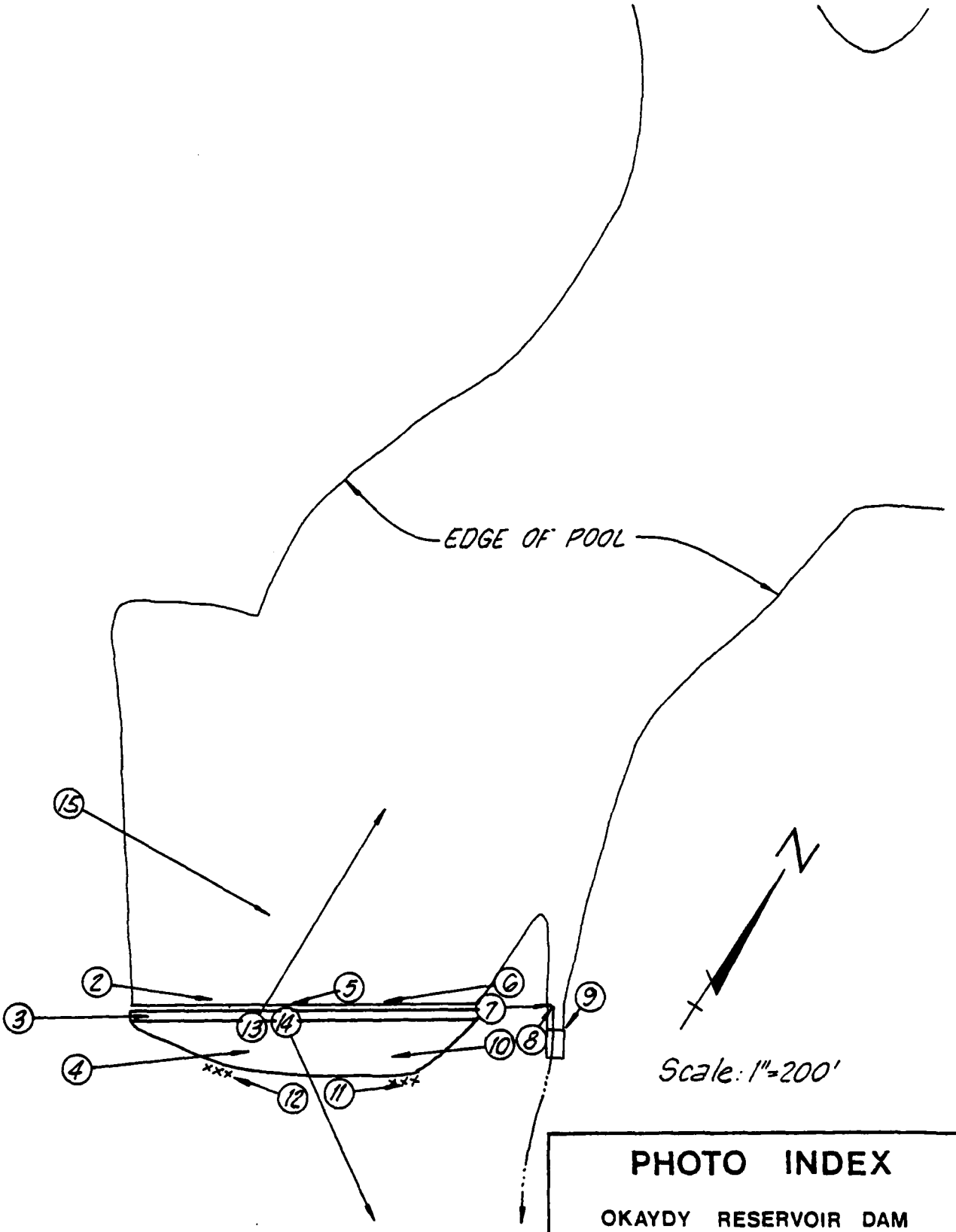


PHOTO INDEX

OKAYDY RESERVOIR DAM

HOWARD COUNTY, MISSOURI

MO. 10001 PLATE B-1

PHOTO NO. 2 - VIEW OF UPSTREAM SLOPE FROM RIGHT ABUTMENT.

PHOTO NO. 3 - VIEW OF CREST FROM RIGHT ABUTMENT.

PHOTO NO. 4 - DOWNSTREAM SLOPE FROM RIGHT ABUTMENT.

PHOTO NO. 5 - ERODED UPSTREAM FACE AT STA. 2 + 10±.

PHOTO NO. 6 - ERODED UPSTREAM FACE AT STA. 1 + 20±.

PHOTO NO. 7 - CREST OF SPILLWAY FROM RIGHT SIDE.

PHOTO NO. 8 - VIEW OF SPILLWAY CREST FROM DOWNSTREAM IN SPILLWAY.

PHOTO NO. 9 - VIEW DOWNSTREAM IN SPILLWAY.

PHOTO NO. 10 - DOWNSTREAM SLOPE FROM LEFT END. NOTE LONE TREE.

PHOTO NO. 11 -

SEEP ALONG TOE AT LEFT END.

PHOTO NO. 12 -

SEEP IN RIGHT ABUTMENT TROUGH BELOW TOE.

PHOTO NO. 13 - VIEW ACROSS RESERVOIR FROM STA. 4 + 50.

PHOTO NO. 14 - VIEW DOWNSTREAM FROM STA. 4 + 50.

PHOTO NO. 15 - OVERVIEW FROM RIGHT ABUTMENT.

APPENDIX C
PROJECT PLATES

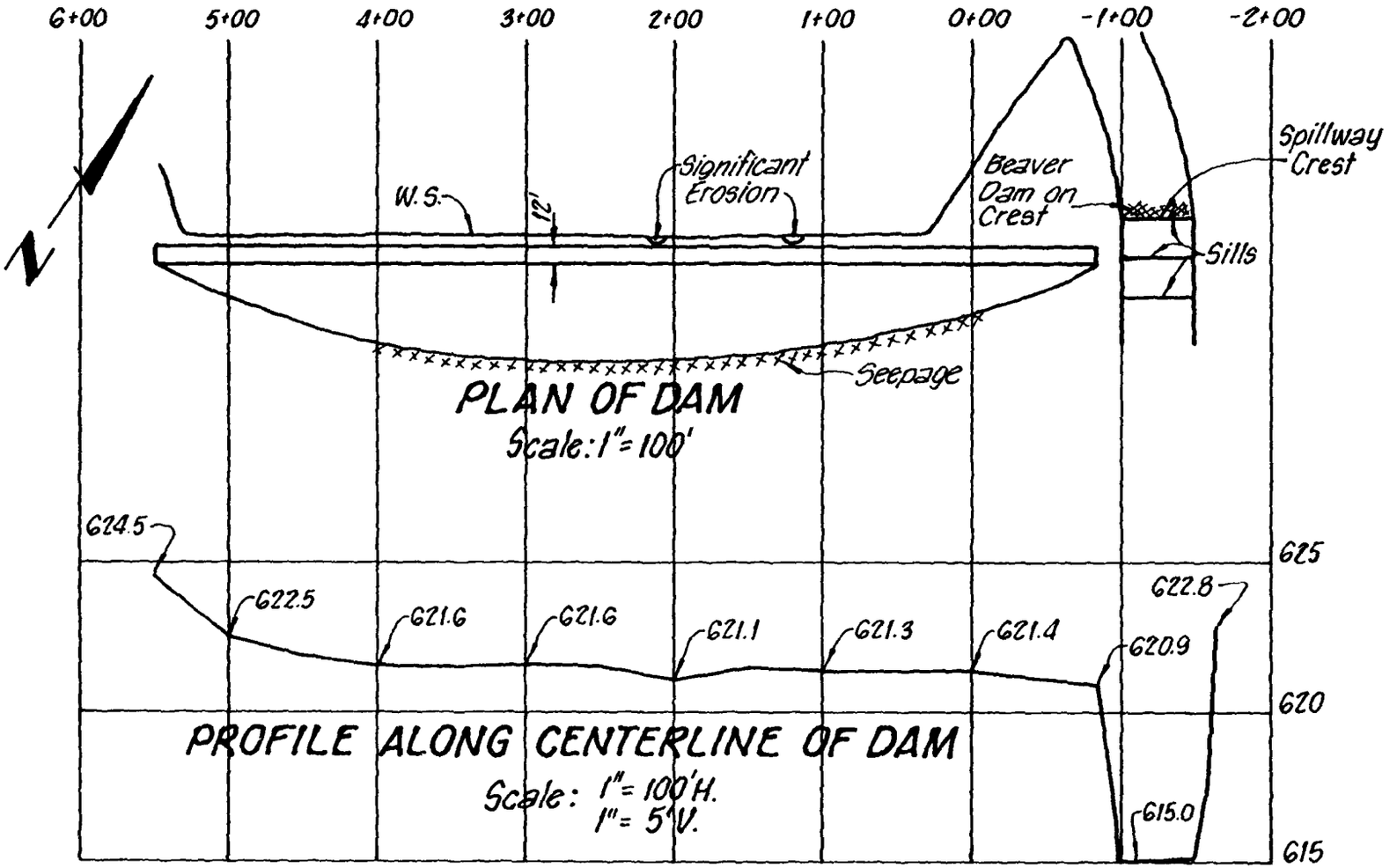
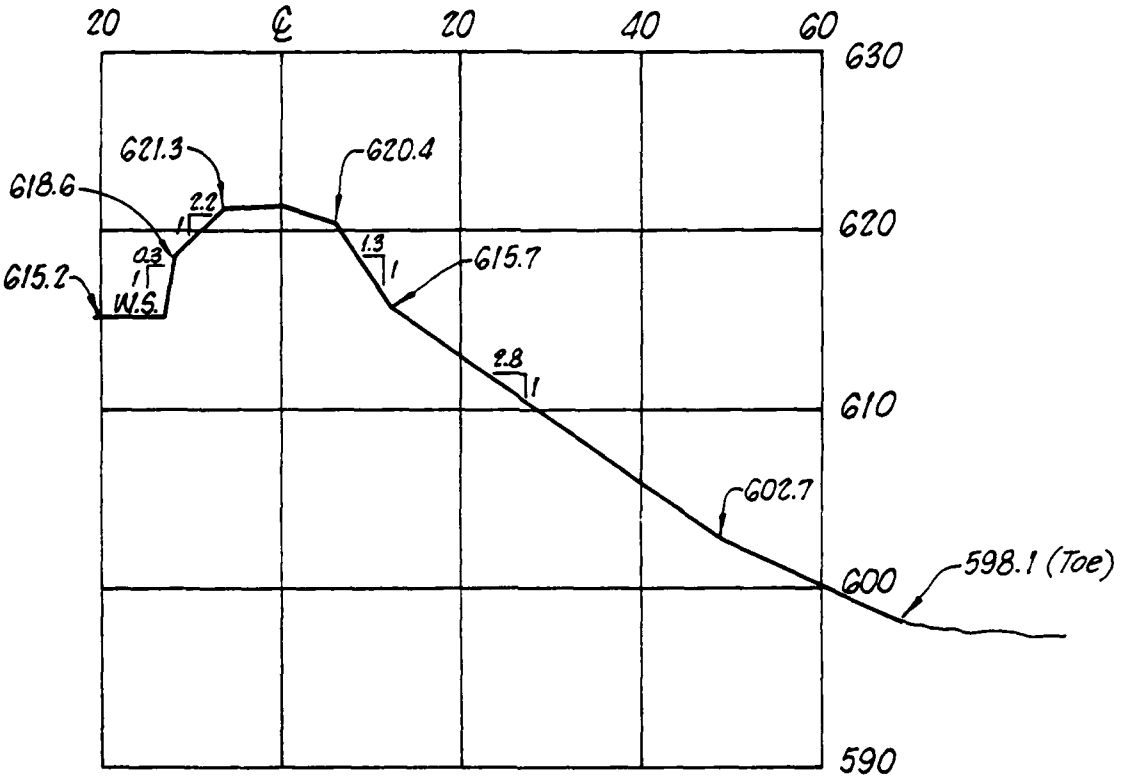
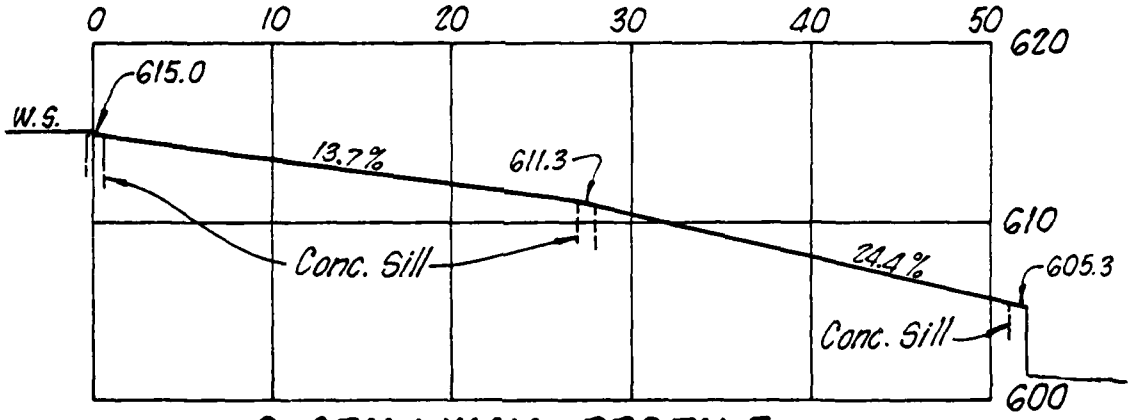

6+00
5+00
4+00
3+00
2+00
1+00
0+00
-1+00
-2+00
N
W.S.
12"
Significant Erosion
Beaver Dam on Crest
Spillway Crest
Sills
Seepage
PLAN OF DAM
Scale: 1" = 100'
624.5
622.5
621.6
621.6
621.1
621.3
621.4
620.9
622.8
615.0
625
620
615
PROFILE ALONG CENTERLINE OF DAM
Scale: 1" = 100' H.
1" = 5' V.

PLATE C-1



SECTION AT STA. 2+50

Scale: 1" = 20'H.
1" = 5'V.



℄ SPILLWAY PROFILE

Scale: 1" = 10'H.
1" = 10'V.

PLATE C-2

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California, were used to develop the inflow hydrographs.

   a. The 24-hour 100-year rainfall for the dam locations were taken from the data for the rainfall station at Jefferson City, Missouri, as supplied by the St. Louis District, Corps of Engineers, per their letter dated 6 March 1979. The 48-hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis District policy and guidance for hydraulics and hydrology.

   b. Drainage area = 2.19 square miles (1403 acres).

   c. Time of concentration of runoff = 1.72 hours as computed by the Kirpich equation.

   d. Antecedent moisture conditions for the probable maximum flood were assumed to be heavy rainfall and low temperatures for the previous five days (SCS AMC III). Antecedent moisture conditions for the 100-year flood were assumed to be an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II).

   e. Initial pool elevation was assumed to be at the spillway crest (elev. 615.0).

   f. Total losses for the 24-hour 100-year storm were 2.57 inches. Total losses for the 48-hour PMP were 1.30 inches. The average loss rate for the 48-hour PMP was 0.03 inch per hour. Losses were determined using SCS CN 78 (AMC II) for the 24-hour, 100-year storm and SCS CN 90 (AMC III) for the PMP. Soils in the watershed are composed of approximately 59% SCS Soil Group B, 35% Soil Group C, and 6% Soil Group D. The soils in the watershed consist of Marshall, Menfro Sharpsburg, and Bremer (SCS soil group B); Gara and Armstrong (B and C); Ladoga, Lindley and Keswick (C); and Chariton (D). Land use in the watershed is approximately 80% cropland and 20% woods.

2. The discharge rating for the spillway was determined using the broad-crested weir equation. The discharge coefficient "C" was varied according to head and corrected for the effects of the downstream slope. (Reference: "Measurement of Peak Discharge

at Dams by Indirect Methods, U.S.G.S.). The discharge coefficient was also adjusted for the effects of the beaver dam and the small trees and brush which are clogging the crest. The resulting values for "C" ranged from 1.5 to 2.8. Head losses in the approach channel, which were computed using the HEC-2 computer program, were also included in the spillway rating.

The discharge rating for the dam crest was developed using the option of the HEC-1 (Dam Safety Version) program for flow over a non-level dam crest.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program. Input, output, and plotted hydrographs are included with this report.

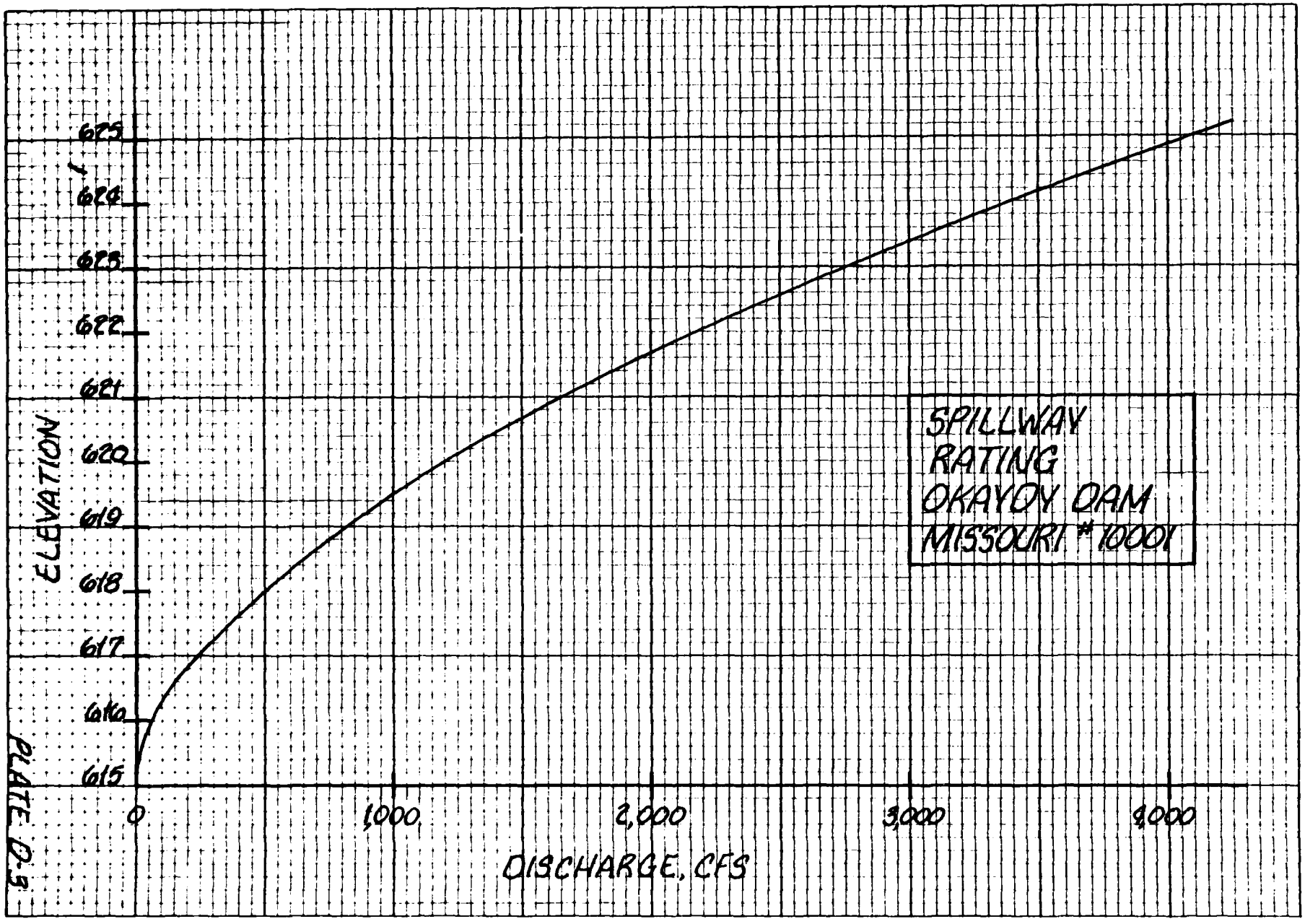
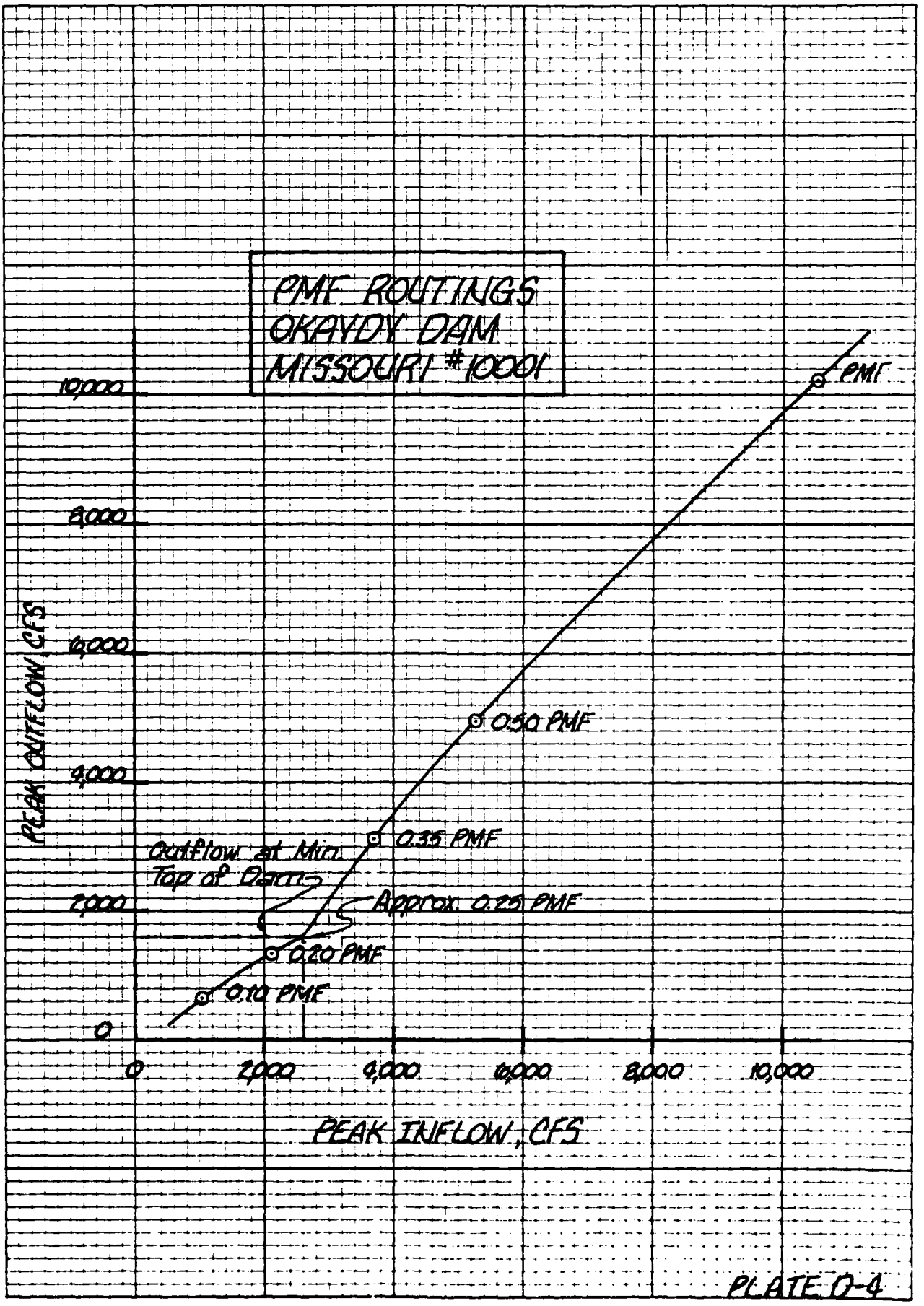

SPILLWAY
RATING
OKAYOY DAM
MISSOURI #10001
ELEVATION
625
624
623
622
621
620
619
618
617
616
615
0
1,000
2,000
3,000
4,000
DISCHARGE, CFS

PLATE D-5


PMF ROUTINGS
OKAYDY DAM
MISSOURI #10001
PEAK OUTFLOW, CFS
10,000
8,000
6,000
4,000
2,000
0
PMF
0.50 PMF
0.35 PMF
Outflow at Min. Top of Dam
Approx. 0.25 PMF
0.20 PMF
0.10 PMF
0
2,000
4,000
6,000
8,000
10,000
PEAK INFLOW, CFS
PLATE D-4

```
A1       MISSOURI DAM SAFETY INSPECTIONS
A2       OKAYOY RESERVOIR DAM
A3       RATIOS OF PMF
B 0002800000000000000010                                          00000003
B1000005
J       1       5       1
J1    .10     .20     .35     .50    1.00
K 00000000000001                  00000002          00000001
K1       CALCULATION OF INFLOW HYDROGRAPHS
M C0800018000000200002.19                        1.0                00000001
P        000024.70000102.0000121.0000130.0000140.
I                                                      -1.     -90.
W2       0001.031
X 000000     -.010000001.
K 00000100000002                  00000002          00000001
K1       RESERVOIR ROUTING OF RATIOS OF PMF
Y                        0000000100000001
Y1000001                                              -615.       -1
Y400615.0000615.2000615.50000616.000616.50000617.0000618.0000619.0000620.0000621.
Y400622.0000623.0000624.0000625.
Y5     0.      7.     26.     78.    150.    250.    500.    820.   1200.   1650.
Y5 2170.   2760.   3400.   4100.
$A00000.0000032.0000059.0000122.
$E00610.0000615.0000620.0000630.
$$000619.
$00620.9000003.0000001.50000650.
$L00000.0000030.0000170.0000320.0000335.0000485.0000535.0000585.0000650.
$V0620.9000621.1000621.4000621.4000621.5000621.5000621.8000622.5000625.0
K 000099
A
A
A
A
A
```

PLATE D-5

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 79/11/21.
TIME= 12.36.34.

MISSOURI DAM SAFETY INSPECTIONS
OKAYOY RESERVOIR DAM
RATIOS OF PMF

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1

RTIOS= .10 .20 .35 .50 1.00

****

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	2	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	2.19	0.00	2.19	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.70	102.00	121.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-90.00	0.00	0.00

CURVE NO = -90.00 WETNESS = -1.00 EFFECT CN = 90.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.03

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 33 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.03 VOL= 1.00

61.	179.	368.	623.	828.	938.	944.	884.	781.	649.
488.	373.	292.	233.	184.	141.	112.	88.	69.	53.
42.	33.	26.	20.	16.	13.	10.	8.	7.	5.
3.	2.	1.							

PLATE D-6

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING OF RATIOS OF PMF

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-615.	-1

STAGE	615.00	615.20	615.50	616.00	616.50	617.00	618.00	619.00	620.00	621.00
	622.00	623.00	624.00	625.00						
FLOW	0.00	7.00	26.00	78.00	150.00	250.00	500.00	820.00	1200.00	1650.00
	2170.00	2760.00	3400.00	4100.00						
SURFACE AREA=	0.	32.	59.	122.						
CAPACITY=	0.	53.	277.	1164.						
ELEVATION=	610.	615.	620.	630.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
615.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
620.9	3.0	1.5	650.

CREST LENGTH	0.	30.	170.	320.	335.	485.	535.	585.	650.	
AT OR BELOW ELEVATION	620.9	621.1	621.4	621.4	621.5	621.5	621.8	622.5	625.0	

STATION 000002, PLAN 1, RATIO 1 (0.10 PMF)

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	1.	1.	1.	1.	1.	2.	2.	2.	2.
3.	3.	3.	3.	4.	4.	5.	6.	6.	7.
9.	10.	11.	12.	13.	14.	15.	15.	16.	16.
17.	17.	17.	17.	17.	17.	17.	17.	17.	16.
16.	16.	16.	15.	15.	15.	14.	14.	14.	14.
13.	13.	13.	12.	12.	12.	12.	11.	11.	11.
11.	10.	10.	10.	10.	10.	9.	9.	9.	9.
9.	9.	9.	9.	10.	10.	10.	10.	10.	10.
11.	11.	11.	11.	11.	12.	12.	12.	12.	12.

PLATE D-7

•CVN•

STATION 000002, PLAN 1, RATIO 5 (PMF)

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	2.	2.	2.	2.	3.	3.	4.	5.	5.
6.	8.	10.	13.	16.	18.	22.	25.	31.	37.
43.	50.	57.	65.	74.	88.	107.	128.	152.	184.
212.	237.	259.	279.	293.	304.	312.	317.	319.	320.
320.	317.	312.	305.	296.	285.	273.	260.	247.	236.
224.	213.	202.	192.	181.	172.	162.	153.	146.	140.
134.	129.	124.	118.	114.	109.	104.	100.	96.	92.
89.	85.	82.	79.	76.	74.	73.	71.	71.	71.
71.	73.	75.	77.	81.	85.	89.	93.	97.	101.
105.	109.	113.	117.	120.	124.	127.	130.	133.	136.
139.	141.	144.	146.	148.	151.	154.	156.	159.	161.
163.	166.	171.	179.	191.	207.	229.	256.	292.	330.
369.	408.	445.	482.	521.	563.	602.	638.	671.	702.
731.	757.	781.	804.	826.	848.	869.	888.	905.	921.
935.	948.	960.	971.	981.	990.	999.	1010.	1028.	1056.
1100.	1161.	1246.	1355.	1476.	1606.	1765.	2005.	2419.	2853.
3233.	3549.	3816.	4049.	4256.	4445.	4638.	4919.	5402.	6171.
7250.	8456.	9478.	10090.	10242.	10010.	9495.	8796.	8051.	7377.
6802.	6310.	5880.	5486.	5106.	4710.	4285.	3838.	3388.	2958.
2577.	2250.	1998.	1841.	1724.	1624.	1537.	1448.	1360.	1274.
1193.	1125.	1061.	1000.	941.	887.	836.	793.	755.	720.
686.	655.	626.	600.	575.	552.	532.	512.		

STORAGE

53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	54.	54.	54.	54.	54.	54.	54.	54.	54.
55.	55.	55.	55.	56.	56.	56.	57.	57.	58.
59.	60.	61.	63.	64.	66.	68.	69.	71.	73.
76.	78.	80.	83.	86.	90.	95.	101.	107.	113.
119.	124.	128.	132.	134.	136.	137.	138.	139.	139.
139.	138.	137.	136.	135.	133.	131.	129.	126.	124.
122.	119.	117.	115.	113.	111.	109.	107.	106.	104.
102.	101.	100.	98.	97.	96.	95.	93.	92.	91.
90.	90.	89.	88.	87.	86.	86.	85.	85.	85.
85.	86.	87.	87.	88.	89.	90.	92.	93.	94.
95.	96.	97.	98.	99.	100.	100.	101.	102.	103.
104.	104.	105.	106.	106.	107.	107.	108.	108.	109.
109.	110.	111.	112.	115.	118.	123.	128.	134.	141.
147.	154.	161.	168.	175.	181.	187.	192.	198.	202.
207.	211.	215.	219.	222.	225.	228.	231.	233.	236.
238.	240.	241.	243.	244.	246.	247.	249.	251.	255.
262.	271.	284.	298.	315.	333.	352.	371.	389.	403.
413.	421.	427.	433.	438.	442.	446.	452.	462.	477.

PLATE D-8

```
   497.     518.     535.     545.     547.     544.     535.     524.     511.     499.
   489.     479.     471.     463.     456.     447.     438.     428.     417.     406.
   394.     382.     371.     360.     348.     335.     323.     311.     299.     287.
   276.     266.     256.     247.     239.     231.     224.     217.     211.     205.
   200.     195.     191.     186.     183.     179.     176.     173.

                                        STAGE
  615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0
  615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0
  615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0
  615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0
  615.0    615.0    615.0    615.0    615.0    615.0    619.0    615.0    615.0    615.0
  615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0
  615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0    615.0
  615.0    615.0    615.1    615.1    615.1    615.1    615.1    615.1    615.1    615.2
  615.2    615.2    615.3    615.3    615.3    615.4    615.4    615.5    615.5    615.6
  615.7    615.7    615.8    615.9    616.0    616.1    616.2    616.4    616.5    616.7
  616.8    616.9    617.0    617.1    617.2    617.2    617.2    617.3    617.3    617.3
  617.3    617.3    617.2    617.2    617.2    617.1    617.1    617.0    617.0    616.9
  616.9    616.8    616.8    616.7    616.7    616.6    616.6    616.5    616.5    616.4
  616.4    616.4    616.3    616.3    616.2    616.2    616.2    616.2    616.1    616.1
  616.1    616.1    616.0    616.0    616.0    616.0    615.9    615.9    615.9    615.9
  615.9    616.0    616.0    616.0    616.0    616.0    616.1    616.1    616.1    616.2
  616.2    616.2    616.2    616.3    616.3    616.3    616.3    616.4    616.4    616.4
  616.4    616.4    616.5    616.5    616.5    616.5    616.5    616.5    616.5    616.6
  616.6    616.6    616.6    616.6    616.7    616.8    616.9    617.0    617.2    617.3
  617.5    617.6    617.8    617.9    618.1    618.2    618.3    618.4    618.5    618.6
  618.7    618.8    618.9    619.0    619.0    619.1    619.1    619.2    619.2    619.3
  619.3    619.3    619.4    619.4    619.4    619.4    619.5    619.5    619.5    619.6
  619.7    619.9    620.1    620.3    620.6    620.9    621.2    621.5    621.7    621.9
  622.1    622.2    622.3    622.4    622.4    622.5    622.6    622.6    622.8    623.0
  623.2    623.5    623.7    623.8    623.9    623.8    623.7    623.6    623.4    623.3
  623.1    623.0    622.9    622.8    622.7    622.6    622.5    622.3    622.2    622.0
  621.8    621.7    621.5    621.3    621.1    620.9    620.7    620.6    620.4    620.2
  620.0    619.8    619.6    619.5    619.3    619.2    619.0    618.9    618.8    618.7
  618.6    618.5    618.4    618.3    618.2    618.2    618.1    618.0

PEAK OUTFLOW IS     10242. AT TIME   40.83 HOURS

                             PEAK    6-HOUR    24-HOUR    72-HOUR   TOTAL VOLUME
                    CFS     10242.     5459.      1811.       940.       270792.
                    CMS       290.      155.        51.        27.         7668.
                 INCHES                23.19      30.76      31.95         31.95
                     MM               588.92     781.36     811.55        811.55
                  AC-FT                2707.      3591.      3730.         3730.
             THOUS CU M                3339.      4430.      4601.         4601.
```

PLATE D-9

CWF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

	0.	2000.	4000.	6000.	8000.	10000.	12000.	0.	0.	0.	0.	0.	0.
.10	11												
.20	21												
.30	31												
.40	41												
.50	51												
1.00	61												
1.10	71												
1.20	81												
1.30	91												
1.40	101												
1.50	111												
2.00	121												
2.10	131												
2.20	141												
2.30	151												
2.40	161												
2.50	171												
3.00	181												
3.10	191												
3.20	201												
3.30	211												
3.40	221												
3.50	231												
4.00	241												
4.10	251												
4.20	261												
4.30	271												
4.40	281												
4.50	291												
5.00	301												
5.10	311												
5.20	321												
5.30	331												
5.40	341												
5.50	351												
6.00	361												
6.10	371												
6.20	381												
6.30	391												
6.40	401												
6.50	411												
7.00	421												
7.10	431												
7.20	441												
7.30	451												
7.40	461												
7.50	471												
8.00	481												
8.10	491												
8.20	501												
8.30	511												
8.40	521												
8.50	531												
9.00	541												
9.10	551												
9.20	561												

PLATE D-10

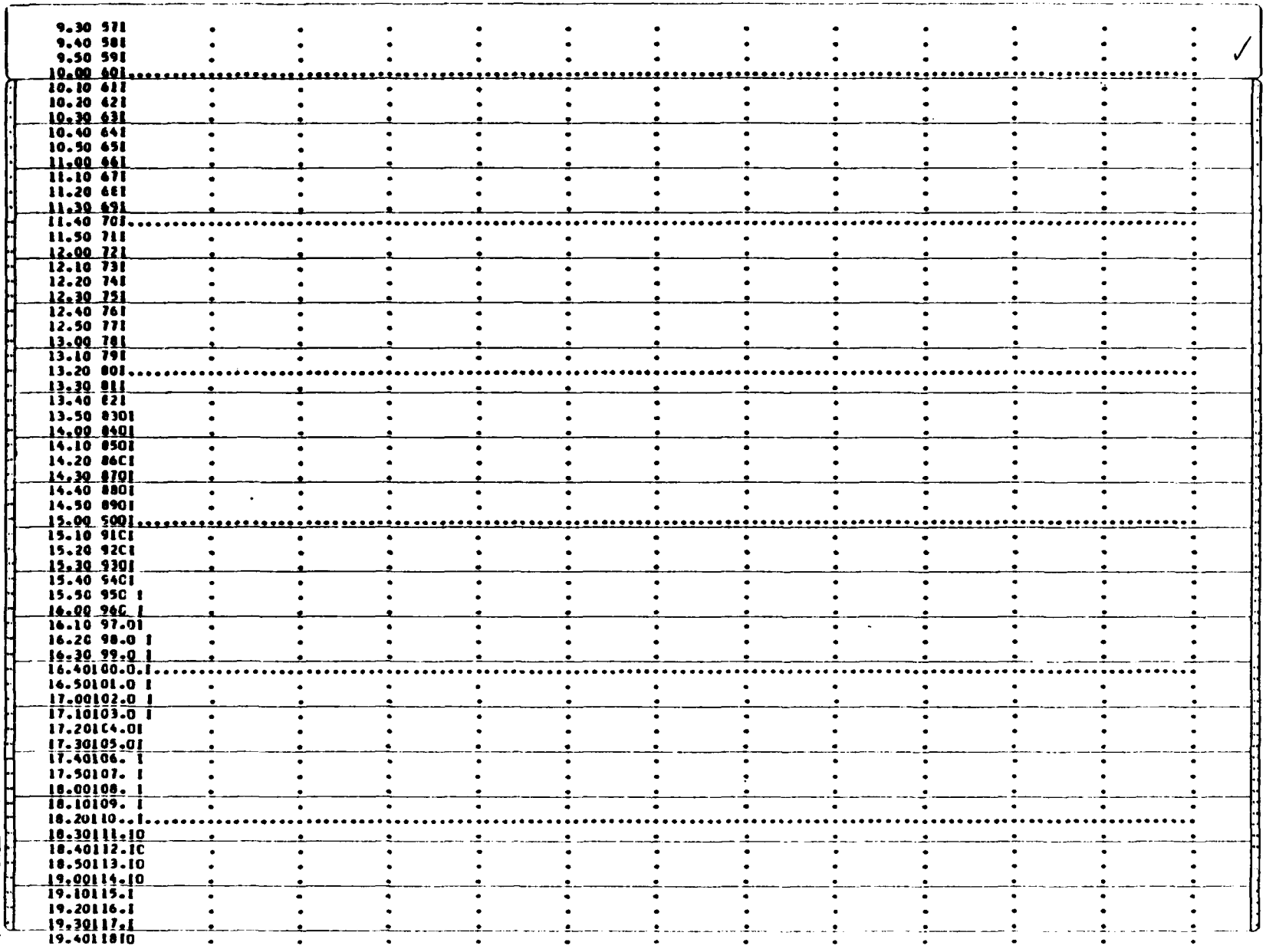


PLATE D-11

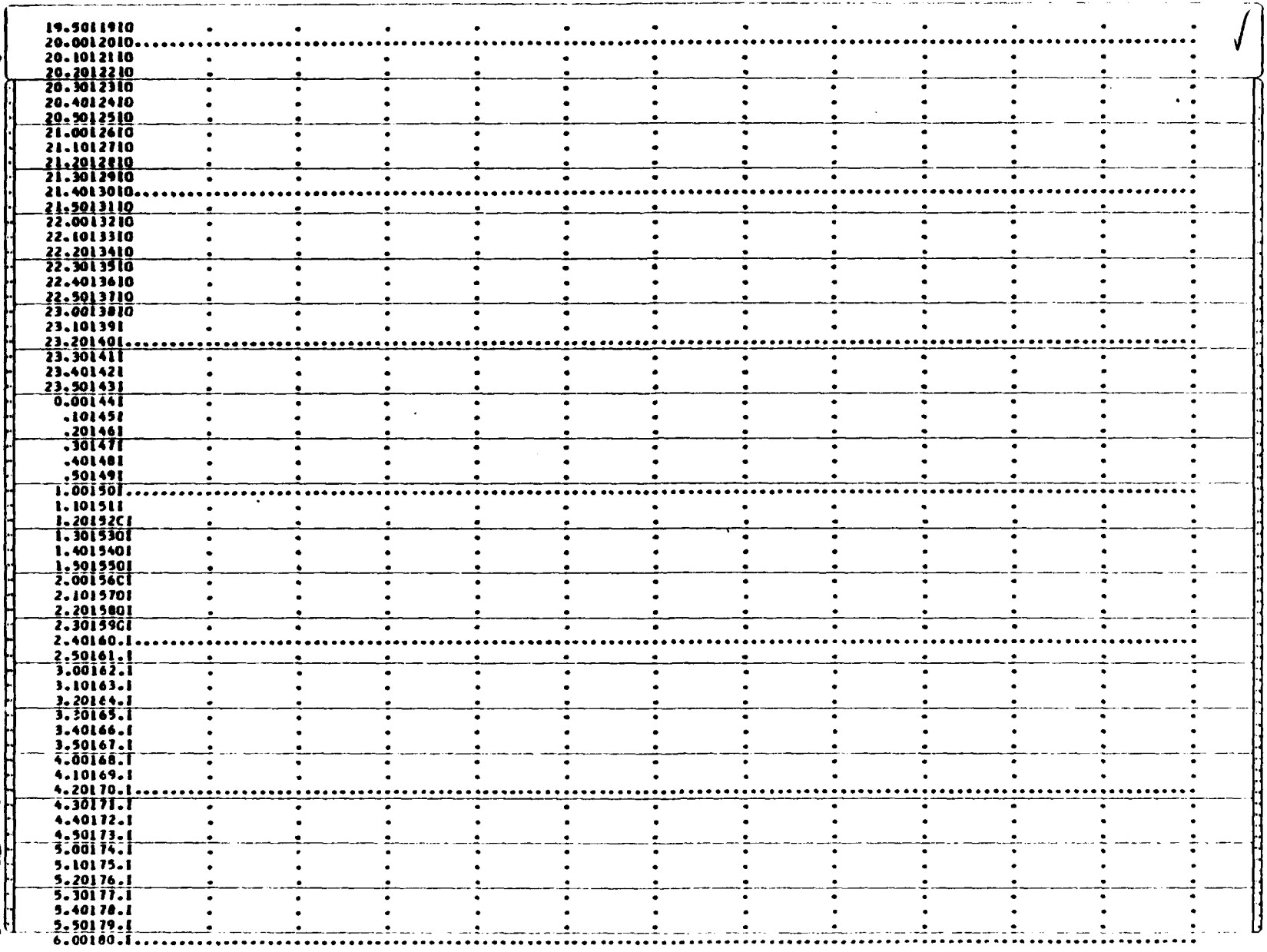


PLATE D-12

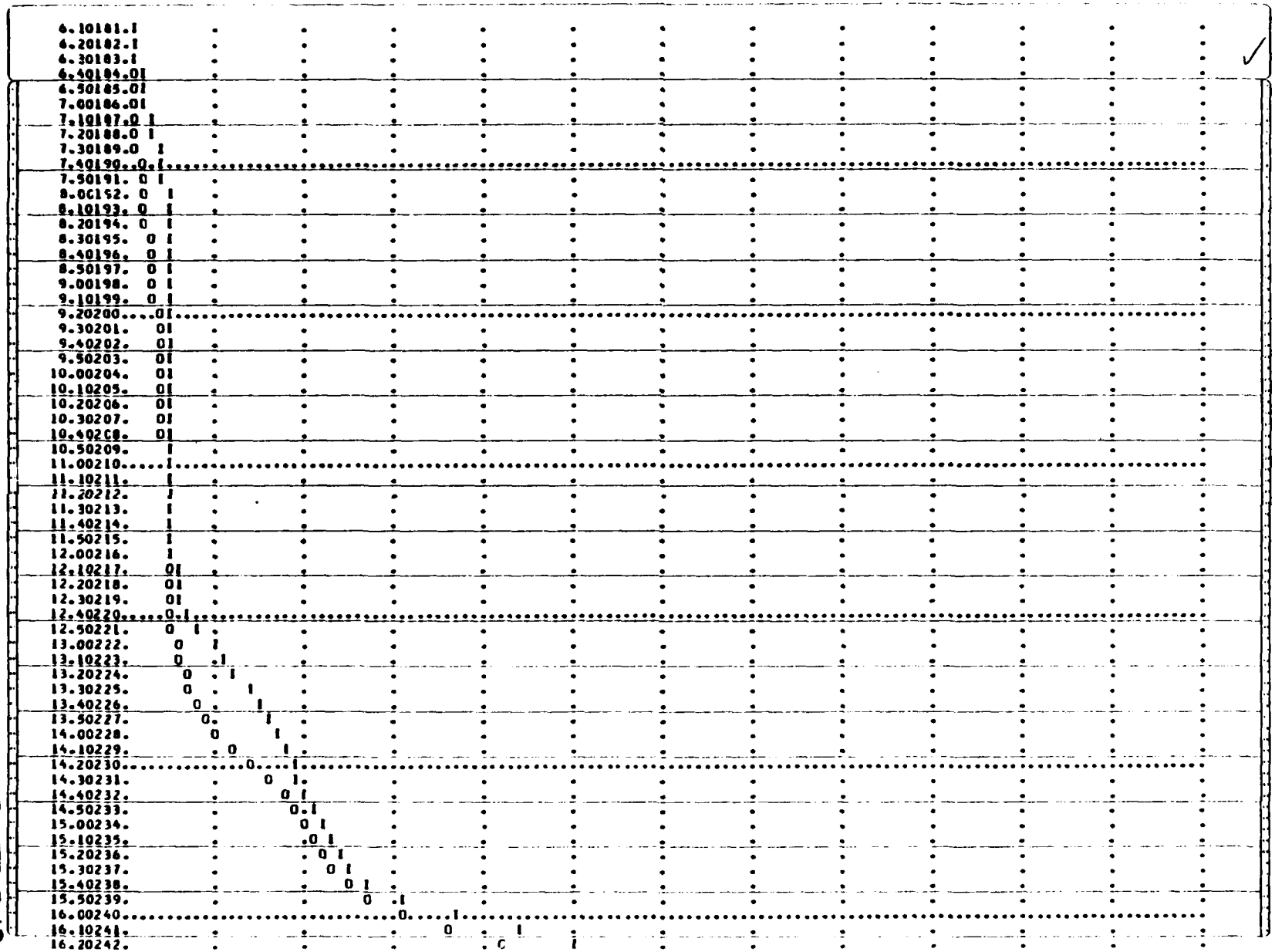
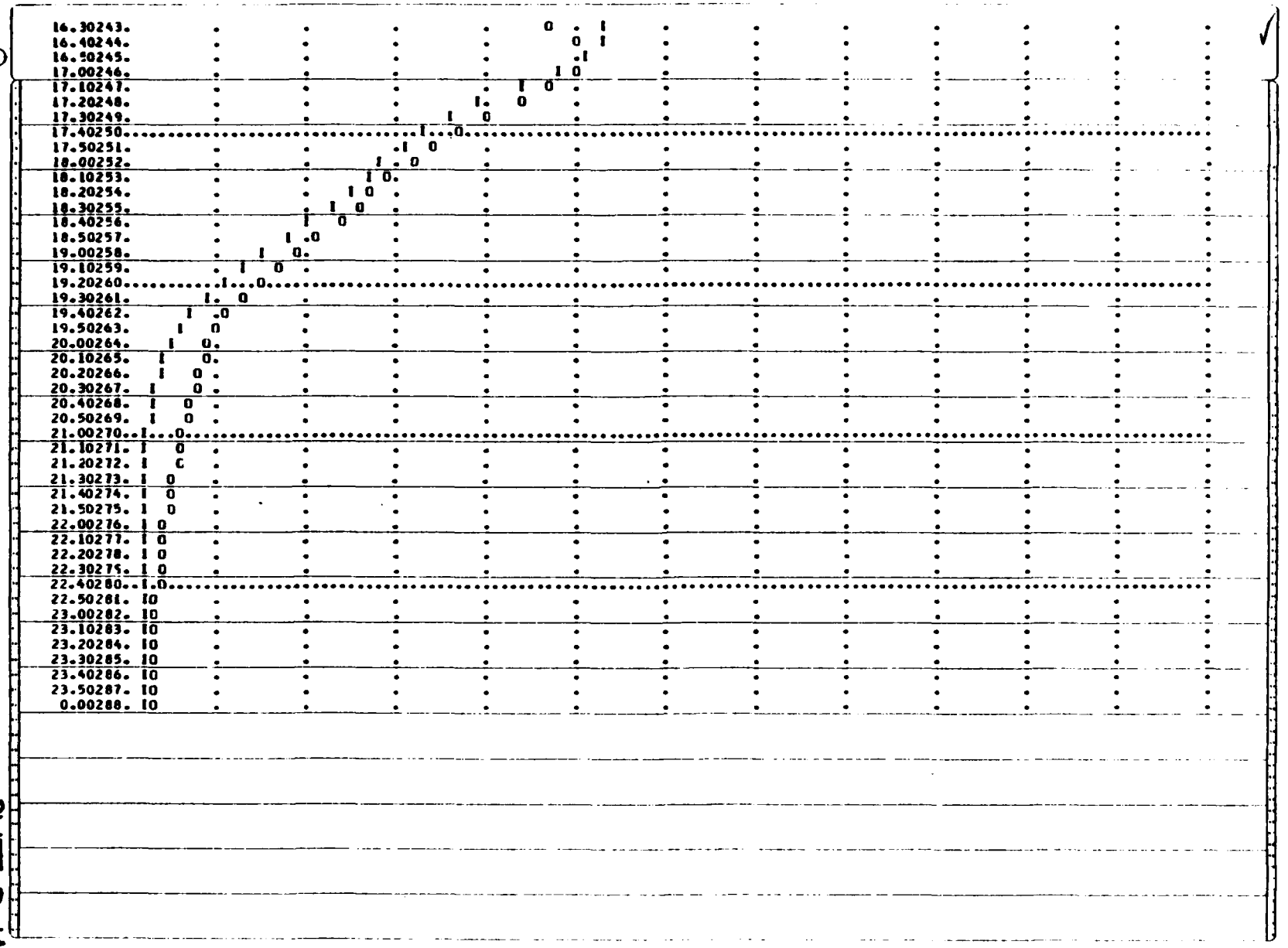


PLATE D-13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23.50287.
0.00288.

PLATE D-14

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .35	RATIO 4 .50	RATIO 5 1.00
HYDROGRAPH AT	000001	2.19	1	1053.	2106.	3685.	5264.	10528.
	(	5.67)	(	29.81)(	59.62)(	104.34)(	149.06)(	298.11)(
ROUTED TO	000002	2.19	1	648.	1370.	3120.	4966.	10242.
	(	5.67)	(	18.36)(	38.81)(	88.34)(	140.63)(	290.02)(

PLATE D-15

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	615.00	615.00	620.90
STORAGE	53.	53.	333.
OUTFLOW	0.	0.	1605.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	618.46	0.00	194.	648.	0.00	41.67	0.00
.20	620.38	0.00	300.	1370.	0.00	41.67	0.00
.35	622.06	1.16	410.	3120.	3.00	41.17	0.00
.50	622.65	1.75	453.	4966.	4.33	40.83	0.00
1.00	623.88	2.58	547.	10242.	6.83	40.83	0.00